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Infrastructure
BUsiness models, valuation and
Innovation for
Local
Delivery

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Are you being served?

Alternative infrastructure business models to improve economic growth and well-being

Newcastle University
UNIVERSITY OF LEEDS
UNIVERSITY OF BIRMINGHAM
EPSRC
Engineering and Physical Sciences Research Council
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

A mid-term review and manifesto from the iBUILD Infrastructure Research Centre • March 2015 • www.ibuild.ac.uk/2015manifesto

The iBUILD Infrastructure Research Centre brings together a multi-disciplinary team from Newcastle, Birmingham and Leeds Universities to improve the delivery of local and urban infrastructure. iBUILD is developing and demonstrating alternative infrastructure business models that:

- take a whole life cycle view of infrastructure systems;
- exploit technical and market opportunities from modern interconnected infrastructure;
- leverage economic, social, environmental, aesthetic and other values from infrastructure;
- identify changes in governance, regulation and policy to unlock improvements; and,
- use innovative financing and funding mechanisms.

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Foreword

Existing approaches to delivering infrastructure are repeatedly criticised for returning poor value for money to the taxpayer and being too narrow to capture the wide range of benefits infrastructure provides to the economy, society and environment. Austerity provides a further stimulus to innovate new ways of delivering, funding, valuing and managing our infrastructure; to improve our infrastructure business models.

Inaction and continued use of existing infrastructure business models will inevitably have detrimental impacts upon the future of the services our infrastructure provides such as sanitation, drinking water, warmth, mobility and communication. These generate jobs and economic activity, provide security and deliver health benefits – greatly improving our quality of life. Extreme weather, increased demands from a growing but also ageing population, new technologies such as electric vehicles, coupled with ageing infrastructure assets, pose profound challenges to the continued reliability and quality of these services.

There has been a recent emphasis in the UK on national scale infrastructure planning. This is welcome and provides an important strategic context. However, this must not be to the detriment of our local and urban infrastructure. It is at these scales where infrastructure services are most concentrated and where most people will use infrastructure services in their everyday lives. Balancing growth across different geographical scales – from the local to the city and city-region – is vital to the success of the national economy. Infrastructure drives local economic growth and job creation, as a result of construction and management activities as well as the enhancement and facilitation of other economic activities. Indeed, a review of a $787bn stimulus programme in the USA[1] highlighted that investment in local infrastructure generated more jobs, more quickly, than large national capital programmes.

To tackle these issues the Engineering and Physical Sciences Research Council (EPSRC) and the Economic and Social Research Council (ESRC) funded Newcastle University, the University of Birmingham and the University of Leeds to establish the iBUILD (Infrastructure BUsiness Models, valuation and Innovation for Local Delivery) research centre in 2013. The research programme scheduled a report eighteen months into its four-year programme, but with a general election looming, and with infrastructure and devolution high on the political agenda, we have summarised research to date as a series of policy recommendations for industry and the incoming government. This manifesto sets out five priority action areas to unlock alternative infrastructure business models. These are supported by more specific recommendations that draw upon a rich and nuanced collection of ancillary evidence that is cited within the report (iBUILD references are denoted by an asterisk) and also found at www.ibuild.ac.uk/2015manifesto. The current programme of research still has two and a half years to go and the research team will continue to add to this body of work.

The conclusions and recommendations here reflect our own interpretation and analysis, but we have benefitted from collaboration and discussion with an extensive stakeholder group from local communities, industry, and local and national government to apply and test our research on real case studies. On behalf of the entire iBUILD team, I encourage you to think about how we can work with you to help localities and urban areas realise their visions and aspirations by unlocking alternative infrastructure business models.

Richard Dawson

Professor Richard Dawson

iBUILD Centre Director

Key messages

Infrastructure business models have a deep-seated influence on the way infrastructure is used, the quality of services that it provides and the equity of public benefit derived from these services. Research from across the iBUILD Infrastructure Research Centre has identified five priority action areas to enable the incoming government and other infrastructure stakeholders to unlock better infrastructure business models. If applied to all infrastructure planning and decision-making, these action areas will help to challenge the "timid, uncoordinated, incremental, wasteful"[2] way the UK currently builds and manages its infrastructure, and help to develop a new approach to delivering infrastructure system and their services that will enhance the health, wealth and security of UK citizens.

Priority Action Area #1: Have a broader, integrated appreciation of infrastructure

Infrastructure is not just tracks, tubes and trunk roads. Failure to consider the resources that flow along these, the services they provide and the people and businesses that depend on them, will lead to investments that don't deliver effectively. At the same time, it is crucial to understand how all these systems are interconnected; infrastructure depends on other infrastructure to work, not just technically, but also economically and socially. The UK's infrastructure is amongst the most mature and interconnected in the world and therefore has a pressing need to adopt a broad, integrated and sophisticated approach to infrastructure planning.

Recommendation 1: *Infrastructure planners, financers, engineers and other stakeholders need to use a broad, but appropriately specified, definition of infrastructure if they are to identify the full range of opportunities from alternative business models. Page 5.*

Recommendation 2: *Housing and 'hidden infrastructure', such as efficiency measures, should be considered alongside the large-scale capital investments with which they interconnect, within infrastructure and spatial planning processes. Page 6.*

Recommendation 3: *National reforms in policy and regulation are required to enable an integrated approach to local infrastructure planning that can identify, and has the capacity to exploit, synergies across infrastructure sectors. Page 7.*

Priority Action Area #2: Enable action at the local scale that connects with the national

Every piece of infrastructure has to go somewhere; it is inherently local. Top-down approaches to infrastructure development and management stop locally-led and innovative business models from flourishing and discourage innovation. This also risks the wrong infrastructure being put in the wrong place at the wrong time because of a lack of local knowledge, engagement and ownership. These issues prevent the UK from maximising returns from infrastructure investment. The UK must devolve an appropriate and sensible proportion of infrastructure investment and responsibility to local institutions so they can deliver infrastructure that better reflects the different geographies, values and needs of the communities it serves, yet remain mindful of the national strategy.

Recommendation 4: *National and local policy frameworks should be realigned to focus on delivering wider societal benefits and to enable local infrastructure business models to emerge that can provide local solutions that are complementary with mainstream systems. Page 9.*

Recommendation 5: *Effective operation of local alternative infrastructure business models requires greater fiscal decentralisation, complemented by a stronger and statutory devolved role for cities and localities in the planning, development and delivery of infrastructure. Page10.*

Recommendation 6: *Provide support for a wider range of innovative local infrastructure financing mechanisms, including tax increment financing, municipal bonds, social impact bonds and crowd source funding approaches. Page 11.*

Priority Action Area #3:
Capture long-term value of every kind

Infrastructure is not only about cash returns. Investment in infrastructure provides wider health, economic and environmental benefits for society; infrastructure converts financial value to social value. A new economic valuation system that recognises these long-term, whole-life returns is essential to maximise the benefits. Infrastructure must also be built for minimum whole-life costs. This might mean paying a bit more upfront for something that will last – and serve – for longer without the need for frequent maintenance; a resilient and sustainable infrastructure.

Recommendation 7: *Incorporate measures of social and environmental benefit (and cost) into infrastructure appraisal frameworks to recognise the wider outcomes and ascertain the broadest possible set of mechanisms to capture revenue and other values. Page 12.*

Recommendation 8: *Implement a quantitative framework within the infrastructure appraisal process to assess the value of flexibility and resilience across the whole system over the long-term. Page 13.*

Recommendation 9: *Local authorities and infrastructure owners should apply resource assessments as a matter of course to identify the potential of land and infrastructure assets to generate long-term, stable revenue streams and not just one-off, short-term windfalls from selling-off assets. Page 14.*

Recommendation 10: *Employ a new approach to infrastructure economics that recognises the long-term and system-wide value of infrastructure provision. Page 15.*

Priority Action Area #4:
Deliver more efficient planning, procurement and delivery

Approaches to project financing, funding and delivery should not be chosen for political reasons. Mechanisms must be adopted that can best deliver the desired economic, social and environmental values, regardless of their political flavour. Many of methods and tools to enable this already exist: the Project Initiation Routemap, Building Information Modelling (BIM) systems, life-cycle assessment, so they must be used. These approaches support more efficient planning and procurement, minimise costs and human effort, preserve the environment, and maximise the potential to reuse and recycle materials and components in the future.

Recommendation 11: *Implementation of the Project Initiation Routemap has been shown to have many cost reduction benefits and should be made standard practise for all public funded projects. Page 16.*

Recommendation 12: *Planning and design of infrastructure should consider the material and resource demands of infrastructure pipelines to identify opportunities for reducing waste in the construction and operation phases, whilst designing for end of life material recovery or repurposing of infrastructure. Page 17.*

Priority Action Area #5:
Accelerate the uptake of innovations through practical action and demonstration

Action often speaks louder than words. Alternative approaches to infrastructure business models are emerging. To quickly identify the most successful approaches and encourage their wide uptake locally, nationally and internationally, a number of ambitious demonstrator sites should be established.

Recommendation 13: *Establish full-scale urban demonstrator sites for integrated infrastructure planning and testing of innovative infrastructure business models. Page 18.*

Priority Action Area #1:
Have a broader, integrated appreciation of infrastructure

Underinvestment in local infrastructure constrains economic growth and also prevents the efficient delivery of local services. How infrastructure is defined, alters how it is valued – this is crucial as a society that undervalues the economic, social, environmental and other contributions from its infrastructure will not prioritise it for investment. Some definitions of infrastrucure focus upon components and networks.[3] Other definitions emphasise societal need and economic growth.[4] While a third group stress the financial value of infrastructure as an alternative asset class.[5] A business model describes the creation, delivery, and capture of value in economic, social, cultural or other terms.[6] A sustainable infrastructure business model secures the resources, financial or otherwise, to construct and manage infrastructure over its life cycle.

A narrow view of infrastructure can constrain innovative thinking and limit the development and implementation of alternative business models. Many current infrastructure business models in the UK are based upon prudential borrowing from the Public Works Loan Board, or use of Private Finance Initiative schemes, and users of infrastructure typically pay through taxation, user tolls or a combination of both. However, the choice and design of infrastructure business models has a profound and far reaching influence on the nature and quality of infrastructure service provision. A service funded exclusively through taxation can provide equal access for all but may ultimately be forced to compromise service quality if demand is too great. User charges can help manage demand according to service needs, but potentially at the expense of equitable access.

To unlock opportunities for business model innovation, an integrated approach that considers the whole infrastructure system from physical components through to the services it provides is essential. This helps identify more opportunities to capture value from across the entire infrastructure system and throughout its life cycle.

Business model lessons from other goods and services sectors

Henry Ford is famous for using the assembly line in his car factories to improve production efficiency, but it was connecting this up with other innovations such as increased wages for his workforce to enhance their buying power and franchise dealerships that enabled rapid growth in sales.

High street video rental store Blockbuster filed for bankruptcy in 2010. Six years earlier it had over 9,000 stores globally, but the company was slow to respond and take advantage of new business model opportunities from digital film distribution enabled by ICT.

App users on smartphones will be familiar with the freemium business model. The basic app is provided for free, drawing in users, but additional features are provided at cost.

Like many other manufacturers, Toyota applied the Just-In-Time principle to their manufacturing processes. However, they were also early adopters of applying these principles across the rest of their system in product development, supplier relations and distribution. Toyota also recognised the important role of people involved in these processes through the principle of "Jidoka" (often referred to as automation with a human touch).

A key lesson from these business models is that whilst physical components and services are important so are the processes, people and mechanisms for creating, delivering and capturing value. A key challenge for the iBUILD research team has been to draw upon the existing work on business models in such goods and services activities to understand and explain what they mean for the particular characteristics of infrastructure.

Recommendation 1: *Infrastructure planners, financers, engineers and other stakeholders need to use a broad, but appropriately specified, definition of infrastructure if they are to identify the full range of opportunities from alternative business models.*

Value – economic, social and environmental - can be captured from across the whole infrastructure system. Lessons from other sectors demonstrate how the services and processes are just as important, if not more so, than the tracks, pipes, cables and other physical components. Infrastructure must be considered, and defined, in terms of a 'whole system' that comprises (Figure 1):

- *physical artefacts* – includes the physical links and components of infrastructure systems such as roads, bridges, pipes and cables;
- *processes* – includes institutions, management, regulation, protocols and procedures that govern the infrastructure over its lifecycle;
- *resources* – includes people, vehicles, water, electricity and data that are conveyed by the physical artefacts and the materials used in the construction of the artefacts; and,
- *services* – such as warmth, mobility, sanitation, transportation and communication that benefit a wide range of users.

It is this whole infrastructure system that supports the health, security, economic growth and wellbeing of modern communities.[7*] Moving beyond a narrow or solely economic view and distinct from the world of more conventional goods and services, an infrastructure business model therefore describes how infrastructure systems create, deliver and capture economic, social and environmental values over the whole infrastructure life cycle.[8*]

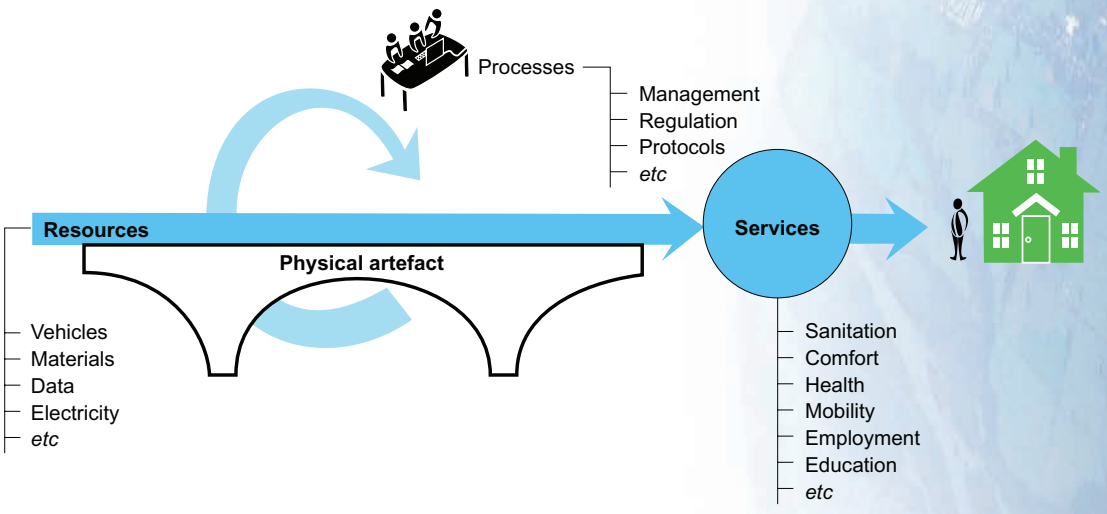


Figure 1. A systems view of infrastructure.

The Royal Albert Hall -
Not all alternative business models are new

The history of local infrastructure going back to the 17th century is one of continual innovation. The Royal Albert Hall was built between 1867 and 1871. Prince Albert wanted the hall to fulfil two functions – a large music hall, and a conference centre – and was determined that it should be funded privately. Henry Cole, secretary of the Science and Art Department, came up with the idea to circulate a prospectus to raise funds by selling sittings in the hall at £100 each.[9]

This was an early implementation of a debentures business model in which a purchaser or investor pays a one-off fee, which goes towards the upkeep of a facility and in return obtains either free tickets, or the opportunity to buy tickets first at face value, to major events held there. The tickets can also be sold on if the purchaser is not going to use them. Most debentures have a short life of 5-10 years, but the Royal Albert Hall is an exception as the debentures are valid for 999 years.

Recommendation 2: *Housing and 'hidden infrastructure', such as efficiency measures, should be considered alongside the large-scale capital investments with which they interconnect, within infrastructure and spatial planning processes.*

UK national infrastructure planning, and specifically the National Infrastructure Plan (NIP)[10], gives limited attention to buildings or property and the important social and economic services they provide. Many local infrastructure plans, including those for Newcastle and Gateshead[11] and London[12] recognise the importance of housing efficiency and demand reduction measures. The UK has some of the oldest building stock in the EU, and as much as 80% is expected to still be in use in 2050.[13] The majority of the UK's housing stock is not particularly energy efficient, and this makes it even harder to address issues of fuel poverty and greenhouse gas emission reductions.

Buildings, and spatial planning more generally, play a critical role in modulating the demands placed upon energy, water and communications networks. Reducing demand for these services through 'hidden infrastructure', such as investment in efficiency measures and demand management strategies, reduces consumer bills, frees up capacity to support growth and regeneration, and defers the need for expensive capital investment in new infrastructure (e.g. for new power stations and water treatment works). The National Infrastructure Plan, for example, sets out a pipeline of £65 billion investment in energy generation and £45 billion investment in energy networks over the coming years. Yet, investing a third of this in energy efficiency measures over the next four decades could free up 12% headroom in generation capacity.[14*] These measures are critical to generating long-term and sustainable economic, social and environmental value and must be co-ordinated more effectively.[15*]

The real cost of street works

The UK has a vast network of underground infrastructure assets, with a total length estimated to exceed 4 million km. Regulatory and commercial pressures mean that infrastructure operators are often incentivised to focus on minimising the direct costs at the expense of possible impacts on other utilities and social costs arising from street works. The intensity of co-location of these underground assets often leads to 'third party damage' to adjacent buried utilities during street works. Analysis of 3,348 such incidents shows that the average damage repair cost per utility varies across sector: Electricity: £970; Gas: £485; Telecoms: £400; Fibre optic: £2800; Water: £300; Sewer and drainage: £980.[16] These costs do not take into account wider disruption resulting from loss of service which can be significantly larger. Ongoing research is costing these indirect loses and considering how new business models can better serve the users and infrastructure service providers.*

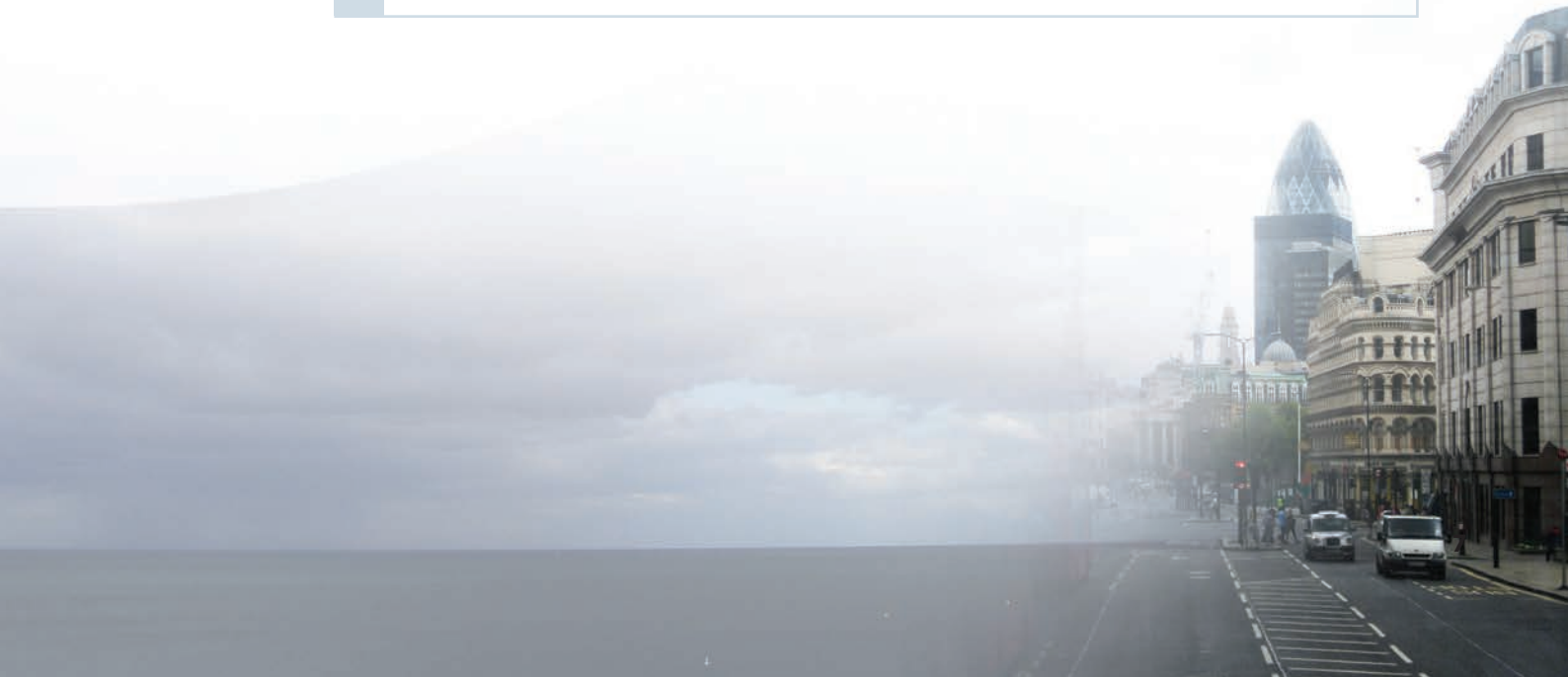
Recommendation 3: *National reforms in policy and regulation are required to enable an integrated approach to local infrastructure planning that can identify, and has the capacity to exploit, synergies across infrastructure sectors.*

Infrastructure systems are increasingly interdependent because of their proximity - for example, utility networks are co-located underneath roads; operational reliance - for example, infrastructure relies on energy or information communication technology; or, economic or regulatory frameworks - for example, assets and systems may share similar investment cycles or finance models. These interdependencies can create risks,[17*] but they also present opportunities for alternative infrastructure business models, particularly at the local level where these interdependencies are closely related and tightly coupled.

The current disjointed nature of local infrastructure planning, investment and management is complex, uncertain and produces inefficient outcomes.[18*] Enhancing coordination, through alternative local infrastructure business models, of the planning, delivery and management of multiple infrastructure classes would enable infrastructure systems to be developed around the principle of providing the highest level of service at the lowest level of resources used. This would generate additional wider social and environmental benefits such as tackling fuel poverty, reducing carbon emissions as well as creating local jobs and reducing costs.[19*,20*] Local actors need additional capacity and empowerment, including more effective decision support tools, alongside national reforms in policy and regulation, to enable places and organisations to integrate local infrastructure provision.[21*] A major appeal of infrastructure to investors is the potential for stable returns at low risk over the longer term. Current governance and regulatory arrangements typically foster investment on a sector or project specific basis which can create objectives that conflict with those taken by an integrated approach. Bundling the physical, social and economic components of multiple infrastructure services into a single investment package is one option to address this.[18*] Ongoing research is exploring the potential for other financial instruments that are consistent with an integrated approach but package investments and returns in different ways that capture value whilst minimising risks for investors, operators, users and tax-payers.

Charged with potential:
The energy-transport nexus

A rapidly emerging interdependence is between electricity and transport infrastructure – most notably uptake of electric vehicles (EVs). iBUILD research, that involved coupling analysis of energy and transport systems models, has demonstrated that distribution networks could accommodate higher growth in electric vehicles than previous studies have suggested. Exploiting the geographic spread and different timings of EV charging can limit the impact on power infrastructure. Distribution network operators should collaborate with new market players, such as charging infrastructure operators, to support the roll out of an extensive charging infrastructure to make both networks more robust. [22*]



Priority Action Area #2:
Enable action at the local scale, that is mindful of the national

The existing division of local infrastructure responsibilities between national government, local authorities, and the private sector creates fragmentation and silos that constrain the development of integrated approaches. Local authorities and other agents must be enabled to cultivate alternative ways of developing and managing local infrastructure of all types. Demands for new infrastructure and maintenance of existing infrastructure are rising, and governments are under pressure to find additional funding and ways of financing infrastructure assets and systems. Local and sub-national actors, including local authorities and community trusts, have shown they are able to take a lead in developing alternative infrastructure business models by combining new and different sources of revenue and longer-term capital. The Greater Manchester City Region's 'earn-back' infrastructure investment model is one such example. A combination of local council tax levies, prudential borrowing and the pooling and scaling of local assets has provided a city region-wide transport infrastructure fund to invest in projects that generate a return which can be subsequently reinvested back into the city region. These approaches are alternatives in the sense of innovating beyond the current status quo or conventional wisdom. Their aims are to deliver a coordinated approach to infrastructure planning that identifies synergies by bundling infrastructures together into the same business model. Limited sub-national institutional autonomy, including the ability to raise and retain local revenue, prevents UK local authorities and other local actors from assuming greater responsibility for planning, co-ordinating, implementing public capital and levering in private investment in infrastructure. It is often national and local governments that have to shoulder the initial risks of infrastructure development in order to create the environment for private finance to then invest in projects that can demonstrate that they are able to generate yields and returns.[23*]

City Deals: A first step?

The UK Government has been considering the role of cities in supporting economic recovery, rebalancing and infrastructure planning and delivery. Between 2011 and 2014, 29 'City Deals' were signed between Local Authorities, Local Enterprise Partnerships and Central Government. A number of City Deals were designed to introduce new forms of infrastructure funding and financing. The City Deals that agreed 'innovative' infrastructure models saw central Government maintain strict fiscal control over their operation and there have been highly uneven outcomes in per capita financial allocations to city-regions. Whilst the City Deals are an important development, when viewed in an international context they do not represent radical decentralisation. A more comprehensive and systemic approach to providing stronger fiscal autonomy and public service integration across cities and local areas, within a stable national framework, to support infrastructure investment and delivery, is required. [24*]

Recommendation 4: *National and local policy frameworks should be realigned to focus on delivering wider societal benefits and to enable local infrastructure business models to emerge that can provide local solutions that are complementary with mainstream systems.*

A review of infrastructure business models shows that alternative institutional forms of organisation and modes of operation are evident where infrastructure services are supplied by a range of actors – such as local authorities, social enterprises or community groups – often working together and through new institutional arrangements.[25*] These local infrastructure business models could deliver additional and wider benefits, but they face constraints which limit their wider uptake.[19*,26*]

Initial iBUILD research has focused on the energy sector, with empirical case studies examining social enterprise, community and municipal energy companies in the UK and internationally. Ongoing work is extending this into other infrastructure sectors. UK energy business models, for example, operate in a privatised and liberalised, but highly regulated, environment. Post-privatisation, energy policy and the regulatory system have evolved around the mainstream mode of operation, which is profit-oriented, throughput-based and large-scale.[27] Local actors are often motivated to achieve goals other than profit generation, such as increased individual and community health and wellbeing through affordable warmth and better air quality. However, current UK regulation views markets and competition as the most effective way of meeting the needs of society. Furthermore, local actors have not played a role in energy governance, beyond spatial planning, since the 1940s. This institutional lock-in is created and reinforced by historical regulatory constraints on the role of local actors and limits innovation. Combined with limited resources and in-house knowledge, there is often insufficient capacity amongst local actors to engage with complex decision processes and this limits the number of stakeholders willing or able to become involved in infrastructure planning and development.[28*]

Indianapolis Citizens Energy Group

In 1887, Indianapolis local civic leaders established a natural gas company as a Public Trust, with an aim to "create the greatest long-term benefit for customers and communities". Today, the Citizens Energy Group owns and operates a large portfolio of physical infrastructure assets that deliver multiple services including energy, water and wastewater for 800,000 people and thousands of businesses in the Indianapolis area. This has provided community services that are entirely compatible with good financial management. The group was awarded a top rating (MIG 1) by Moody's credit rating agency in 2014, a reflection, in part, of the strength of the company's infrastructure business model.[29]

Recommendation 5: *Effective operation of local alternative infrastructure business models requires greater fiscal decentralisation, complemented by a stronger and statutory devolved role for cities and localities in the planning, development and delivery of infrastructure.*

The UK is a centralised political economy, with a highly concentrated system of taxation and expenditure, in an international context (Figure 2). The UK's 'tax to GDP ratio' is 35%, according to the Organisation for Economic Cooperation and Development, and local government is responsible for raising 1.7% of tax revenue as a percentage of national GDP. In contrast to many other countries, infrastructure decision-making in UK cities and localities is dominated by centralised mechanisms, which can hinder local innovation and experimentation as the funding, financing and revenue raising powers are inappropriate for delivering local infrastructure and growth. London, for example, relies more heavily on inter-governmental transfers than locally-raised revenues, compared to global competitor cities, such as New York, Paris and Tokyo.[30*] In a time of austerity, local government budgets have been reduced significantly. Whilst the UK Government has introduced some reforms to local authority finance in England, iBUILD research reveals that the ability of localities to reap and reinvest (in infrastructure) more of the proceeds of growth remains constrained.[31*] The issue has been given fresh impetus in wake of the Scottish independence referendum. In a fiscally-constrained environment, iBUILD analysis highlights the benefits to the UK economy, in terms of recovery, renewal and rebalancing, of central government adopting a more appropriate, planned and a flexible approach to fiscal decentralisation, which would enable local areas to retain more locally generated revenue.[32*] This must be accompanied by broader devolution of infrastructure planning, regulation and delivery. In return, cities and local areas should play a more prominent role within national infrastructure planning than they do currently.

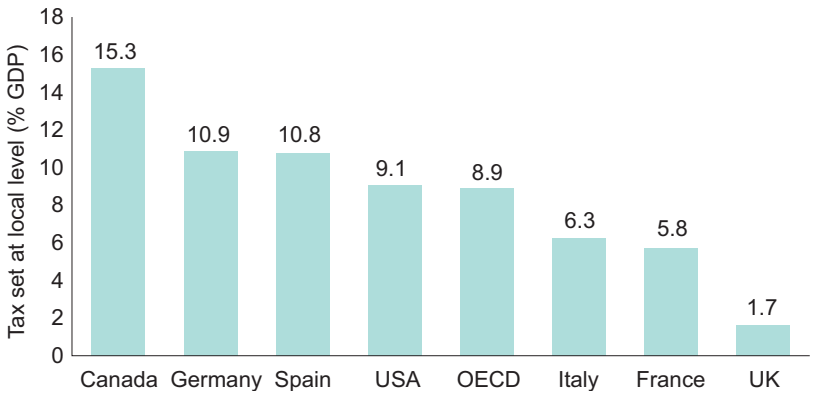


Figure 2. Tax set by all sub-national governments in selected OECD Member States as a % of 2011 National GDP (OECD data is for 2010).

Revolving investments funds for local infrastructure

Revolving funds are accounts that remain available to finance continuing operations without any fiscal year limitation on the premise of loan or equity investment generating returns or repayment that are invested in new projects. They can be applied to a variety of different forms of infrastructure with varying structures, scales, business models and governance arrangements. iBUILD research is assessing the operation of revolving funds for financing energy-efficient retrofit (EER) in housing. The modelling captures savings created by EER and uses data from relevant sources to consider how much additional EER could be financed by a revolving fund. Assessment of both national and regional-level schemes envisages how a variety of different scenarios for recycled funds would operate. Outcomes indicate the considerable possible impacts of a revolving fund for EER, including reductions of up to 26% in the new investment required for national retrofit schemes or the financing of extensive subsidisation schemes at the local level. The research goes on to consider the implications for governance in this area.[13*]

Recommendation 6: *Provide support for a wider range of innovative local infrastructure financing mechanisms, including tax increment financing, municipal bonds, social impact bonds and crowd source funding approaches.*

In response to constraints on traditional sources of infrastructure finance, there has been a great deal of focus on attracting private finance, including pension funds, to invest in resilient and sustainable infrastructure. Not all infrastructure is of an appropriate scale for these forms of finance and not all projects can guarantee sufficient financial returns on investments in the short-term. Securing finance that is appropriate to the geographic and temporal scale of projects and maximizes the potential to create local social and economic value presents significant challenges. Analysis reveals the potential for alternative forms of local infrastructure finance that are relevant to the scale and outcomes of infrastructure and satisfy restrictions placed on public sector actors (through the prudential borrowing code). Figure 3 shows a number of these that are technically suitable for adapting infrastructure to climate change, such as bonds, revolving funds and crowd-source funding, but are currently under-used in infrastructure delivery.[34*] As with any financing scheme, care must be taken to ensure the business model is viable and aligned with the desired outcomes.

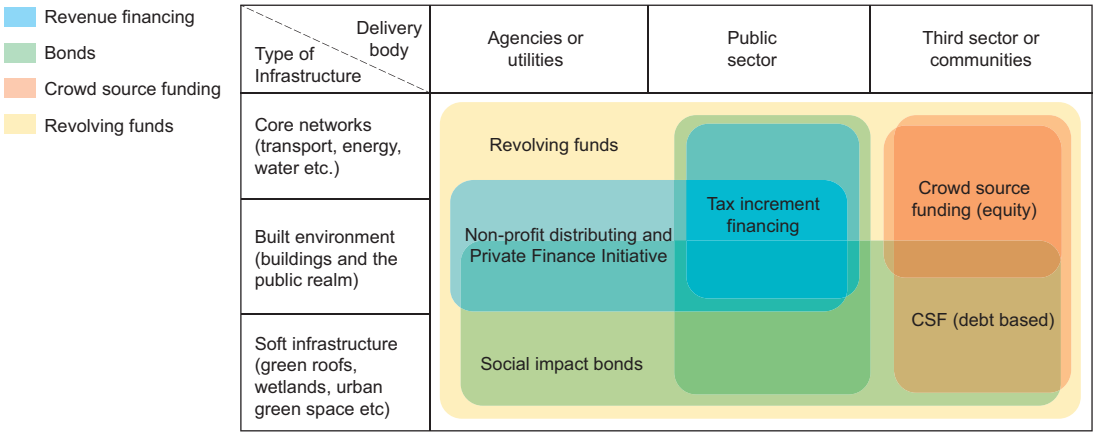


Figure 3. Potential use of alternative funding mechanisms.

Priority Action Area #3:
Capture long-term value of every kind

Infrastructure provides many direct benefits, but many more which are diffuse across the whole economy and society, and endure through time. Typically, infrastructure investments are appraised using conventional cost-benefit and multi-criteria analyses. In the UK, this includes the approach set out in HM Treasury's Green Book[35] which is are often elaborated with specific guidance for individual infrastructure sectors, for example by the Department for Transport's Web-based Transport Analysis Guidance[36] and the Environment Agency's Flood and Coastal Defence Project Appraisal Guidance.[37] Standard economic approaches typically assume that individuals are rational, markets behave in an efficient fashion and environmental, demographic and other socio-economic factors are stationary. It is inevitable therefore that existing approaches only partially assess the true long-term economic, social and environmental cost and benefits of infrastructure. A key consideration for capturing value is the purpose of the infrastructure service; is it to maximise revenue, or to provide an affordable service or amenity to citizens and businesses?

Recommendation 7: *Incorporate measures of social and environmental benefit (and cost) into infrastructure appraisal frameworks to recognise the wider outcomes and ascertain the broadest possible set of mechanisms to capture revenue and other values.*

Existing economic approaches to valuing infrastructure are unable to capture all societal dimensions or reflect decision-makings at individual, community or political scales.[38*] Guidance for infrastructure appraisal has begun to recognise the importance of labour market participation, resilience, linked networks, and local and regional impacts. The UK Public Services (Social Value) Act 2012[39] enables a commissioning body to consider securing additional economic, social or environmental benefits for their local area. Whilst there are methods to monetise time spent in traffic congestion or the detour associated with a bridge closure, for example, existing approaches do not expose how this would affect an individual, a family, a business or a community. Similarly, cycling and green infrastructures, such as urban parks and wetlands, contribute to social goals such as those related to health and well-being, as well as offering sustainable economic growth and environmental benefits.[40*] iBUILD research is highlighting how understanding the social perception and use of infrastructure exposes a spectrum of benefits,[41*] and that methods such as social and environmental accounting and audit, or social return on investment, are able to assess and capture these.[42*] The benefit of these approaches is well-established in assisting the provision of community services and identifying beneficiaries of these services.[43*] The potential to complement these with a form of social infrastructure investment bond – where revenue is tied to achievement of social outcomes from infrastructure services – is a promising means of unlocking finance and engaging with new actors.

Broadband For The Rural North (B4RN)

(Photo courtesy of B4RN)

The provision of high quality broadband to properties in the rural areas of the UK is an ongoing challenge as it is not considered economically viable using mainstream methods. B4RN have built a community-owned gigabit fibre optic broadband network in the sparsely populated, rural uplands of Lancashire in the north west of England. Attempts to use existing infrastructure networks to carry the fibre were hampered by existing regulation that discourages such sharing. Costs were reduced: by laying optical fibre cables across land owned by members of the co-operative (as opposed to alongside roads); by members carrying out much of the installation work themselves; and, by members investing in the scheme receiving tax relief through the Government's Enterprise Investment Scheme. To date, nearly 500 km of duct has been installed and nearly 1000 properties have been connected at a rate of between 50 and 100 properties per month. The scheme has expanded into North Yorkshire with connections in Cumbria imminent.

Recommendation 8: *Implement a quantitative framework within the infrastructure appraisal process to assess the value of flexibility and resilience across the whole system over the long-term.*

Recent extreme weather events have tested the UK's ageing infrastructure systems and exposed a limited long-term view over investment and improvements to enhance resilience.[44,45] Predicted changes in the climate and socio-economic development will, without appropriate action, increase the risk of disruption from extreme weather. However, valuing the benefits of measures to enhance the resilience of infrastructure is challenging because of the long – often generational – timeframes involved and the relatively low frequency of extreme events under consideration. For example, flood defence appraisal guidance can bias investment towards the protection of housing and individuals, but this could be to the detriment of investing in protection for individual infrastructure assets, such as road links, that provide critical services to entire communities. Transport infrastructure appraisal is biased towards benefits that improve system performance under normal operating conditions.[46*] This can leave whole regions at the mercy of conventional benefit-cost ratios that lack consideration of wider economic and social value, strategic importance and interdependencies with other infrastructure services.[47*] Crucially, it is important to think about the resilience of the service, which may include the role of measures such as behavioural change and spatial planning and not just reparation or strengthening of assets.

A review of international infrastructure business models has highlighted the risks of public and private sectors focusing on short-term financial gain instead of taking a long-term, strategic perspective on infrastructure, spatial planning and urban development.[25*] To enable infrastructure systems to respond to future uncertainties in environmental, demographic and economic conditions, it is essential to consider future flexibility (i.e. to what extent options become closed) within an appraisal process. Infrastructure's long lifespan means that it is particularly important to consider long-term changes and uncertainties, to understand the true cost of disruption to infrastructure (e.g. in terms of access to employment, productivity, health and wellbeing), the costs of measures to enhance resilience and the opportunity costs of measures that reduce future flexibility.

Flexible options for the London-Penzance railway line

The collapse of the London-Penzance railway line at Dawlish in Devon was a high profile infrastructure disruption and left the region without a main railway connection to the rest of the UK for 5 months. Situated just a few metres above mean sea level, the line has been susceptible to frequent closure during high seas and storms ever since it opened in 1846. The past 30 years have seen the problem worsen, coinciding with rising sea levels, but the current damage is the most severe in its 178 years of service. A few centimetres sea level rise could double disruption on the line.[47*] *The need for a flexible, integrated and long term strategy is therefore particularly acute. Such approaches have shown great promise for long term planning of flood management in the Thames Estuary and the Netherlands.*[48] *This must involve linking short term decisions about the railway with wider social, environmental, development and investment agendas. Strategies that are relatively easy to accelerate or delay, for example in the face of accelerated or slower than expected sea level rise, or facilitate switching between different approaches, can be considered flexible.*

Recommendation 9: *Local authorities and infrastructure owners should apply resource assessments as a matter of course to identify the potential of land and infrastructure assets to generate long-term, stable revenue streams and not just one-off, short-term windfalls from selling-off assets.*

Central government, local authorities, utility owners and many other stakeholders are sitting on land and assets that could be more effectively used to provide new revenue streams.[49] On-going budgetary pressures have forced local authorities to consider a range of options for raising revenue and improving efficiency. This has led to the sale of significant amounts of property and land. iBUILD research has explored how resource mapping can be used to identify sustainable business models that take a longer-term view over unlocking new revenue streams whilst delivering wider social and environmental benefit.[50*]

Developments in urban energy resource assessment modelling enable potential revenue streams to be calculated using spatial mapping to overlay resource potential and local authority asset locations. For example, a case study in Leeds analysed the renewable electricity generation potential of over 6,500 sites owned by the City Council.[51*] This work was combined with information on generation and export revenues, avoided electricity costs and operational costs to assess net returns. Of the sites analysed, over three-quarters delivered a positive return for all generation options considered, with 334 sites returning a net present value of £100,000 or more for at least one option.

Resource potential will inevitably depend on the asset inventory and geography of each local authority; this study nevertheless suggests there are enormous untapped resources across the UK. Work to date has focused on wind and solar energy generation potential, but future research will extend this to consider other natural resources as well as financial schemes to unlock asset capital value.

Chicago parking – upfront payment at the expense of long term lock-in

Chicago raised a seemingly impressive $1.16bn in 2008 by leasing its 36,000 parking spaces for 75 years to a consortium led by Morgan Stanley in partnership with Allianz and the government of Abu Dhabi. Parking fees in Chicago rapidly rose and the deal has created new costs for the city to compensate for periods when the meters are taken out of use, including during streetworks, public festivals and to offer free disabled parking. Furthermore, the deal penalises innovation in the transport sector as implementation of any measures to improve safety or to deliver more sustainable transport options incur additional penalties.[52] Subsequent analysis has suggested the city substantially undervalued the deal and should have asked for over $2bn.[53] This is consistent with other public sector infrastructure being undervalued which can stem from misunderstanding how private investors package and assess future revenue.[54]

Recommendation 10: *Employ a new approach to infrastructure economics that recognises the long-term and system-wide value of infrastructure provision.*

Understanding the wider benefits of infrastructure and how decisions affect a wide variety of interests is crucial when the services infrastructure provides are disrupted, in need of rebuilding, repairing or replacing. Considering the other dimensions of value identified in the previous sections is important, but upfront finance and ongoing funding are necessary factors in the continuing viability of infrastructure provision.

Standard economic theory, including its application in the infrastructure sector, often refers to 'market failures', and is based upon instances when the economic and financial valuation of infrastructure diverges from what is considered socially and economically valuable in the long run. There are three reasons why the traditional assessment and evaluation approach of cost-benefit analysis may be inappropriate as an appraisal tool for infrastructure:

(i) the uncertainty inherent in the long run and system-wide duration and impact of infrastructure;

(ii) the interdependence of attitudes, preferences and behaviours of individuals with the infrastructure systems with which they interact (i.e. infrastructure can shape preferences and values so the latter cannot be used as fixed guides for evaluation); and,

(iii) the system-wide impacts of infrastructure on economic growth and society which require a system-wide analysis beyond the scope of standard cost-benefit analysis.

Just as there is a need for a systems assessment of social and environmental benefits, iBUILD research has shown that a similarly broad view of economic costs and benefits is also crucial. This helps unlock future funding and finance by identifying economic values of the systems of infrastructure provision that include those benefits that are diffuse across the economy and society and over long timeframes.[55*]

Priority Action Area #4:
Deliver more efficient planning, procurement and delivery

It has been widely recognised that the diversity of infrastructure assets and their supply chains, the interactions between organisations, and the physical scale of the infrastructure itself, pose significant challenges for infrastructure delivery.[56,57] Furthermore, the nature of these challenges evolves over the infrastructure life cycle, from initiation and design through procurement, delivery, operation to decommissioning or repurposing. Maximising the value from infrastructure will make it a more attractive investment proposition, but in an era of austerity there is an equally great imperative to identify opportunities across the whole infrastructure life cycle to deliver greater benefits and efficiencies. These issues are spanning larger spatial scales, such as the city-region, and posing significant challenges for local infrastructure provision.

Recommendation 11: *Implementation of the Project Initiation Routemap has been shown to have many cost reduction benefits and should be made standard practise for all public funded projects.*

The Project Initiation Routemap[58] (Infrastructure Routemap) is a set of principles and assessment analytics designed to inform initiation, procurement and delivery strategy. The Infrastructure Routemap, developed in partnership with IUK and the construction industry, is aimed at improving initiation and delivery throughout the project lifecycle, particularly at the early phase of initiation, where decisions on project governance, requirements, risk and procurement can have the greatest impact on outcomes.

iBUILD research has highlighted how organisational design, including culture, goals, values, vision and people, is as important as task-oriented aspects, such as: work organisation and practices; procedures and processes; supply chain capabilities, technology and assets.[59*] The Infrastructure Routemap provides an objective assessment of the complexity of the organisation and delivery environment, and also of the capability of the sponsor, client and supply chain. The identification of any misalignment between critical success factors, key risks and opportunities can be identified at an early stage, allowing sponsors and clients to work together to improve delivery. Research by iBUILD has analysed a number of case studies and pilot implementations of the Infrastructure Routemap[60*] and revealed a number of significant benefits that include:

(i) Greater stakeholder support for the investment at an early stage through alignment and understanding of objectives, expectations and appropriate incentives.

(ii) More streamlined delivery achieved by systematically matching sponsor, client and supply chain capabilities and requirements.

(iii) Reduced delays and costs as a result of planning for transition between different phases of the infrastructure lifecycle.

Recommendation 12: *Planning and design of infrastructure should consider the material and resource demands of infrastructure pipelines to identify opportunities for reducing waste in the construction and operation phases, whilst designing for end of life material recovery or repurposing of infrastructure.*

Infrastructure requires significant volumes of materials for its construction, maintenance and operation. The physical scale of infrastructure often requires quantities of raw materials that outweigh many other industrial demands, and their extraction has environmental, economic and ultimately social costs. The UK's National Infrastructure Plan[63] and plans for increased low-carbon technologies[64] will place increased demands on indigenous materials (e.g. bulk construction materials), and those imported from foreign markets (including rare earth metals). These demands are not unique to the UK and yet the commodities are finite. iBUILD research has shown how movements of such resources are already subject to short-term disruptions.[65*]

Over longer timeframes, planning and design of infrastructure must consider dependence on materials, but iBUILD research highlights how diversity, long recognised as important for resilience in ecological systems, is also an important quality for infrastructure resilience. Moving wholesale to the seemingly 'most efficient' assets and technologies in the short-term can have the unintended consequence of locking systems into modes of operation that are vulnerable to disruptions in supply (including materials and other sources of volatility in the operating environment) but also locking communities into existing technologies that are expensive to replace or upgrade. For example, renewable energy infrastructure plans may be exposed to a nine-fold increase in materials risk over the next few decades depending on the technologies used.[66*] Retaining a suite of technologies to deliver a given infrastructure service will deliver a more sustainable and flexible business model in the longer term.[67*] This could be facilitated by an infrastructure equivalent of 'Building Information Modelling' systems.

Closing material and energy loops locally with integrated infrastructure in Kalundborg, Denmark

Since 1972, this industrial park has evolved from a single power station into a cluster of companies that exchange materials and energy for mutual benefit as by-products from one business are often inputs for others. For example, treated wastewater from a refinery is used to cool a power station which in turn provides steam for the refinery and a pharmaceutical plant. Surplus heat from the power station is also used for warming nearby homes and businesses. This has led to substantial annual savings of resources and costs – for example, a reduction in water consumption of 3.3million m^3/year, savings of $15m from resource sharing and far larger savings by sharing infrastructure have been reported – highlighting how integrated infrastructure business models can produce substantial savings.[61,62]

Priority Action Area #5:
Accelerate uptake through practical action and demonstration

Recommendation 13: *Establish full-scale urban demonstrator sites for integrated infrastructure planning and testing of innovative infrastructure business models.*

There are a number of opportunities to obtain enhanced benefits and savings from infrastructure through the implementation of alternative sustainable business models. The first 18 months of the iBUILD programme have already produced a number of policy relevant recommendations discussed in this document. Many more evidence-based recommendations for the policy, industrial and financial sectors are expected as the research programme further matures.

It is clear that business models need to take a longer-term view, balancing capital funding and finance over the full lifecycle to achieve a sustainable and high quality delivery of service. The fragmented and siloed nature of local infrastructure is currently inefficient; coordinating the delivery of multiple infrastructure sectors across and between scales creates the potential to reduce costs, create wider societal plans and economic benefits and environmental improvements. An integrated approach to infrastructure delivery, multiple assets and services can be managed as a 'bundle' and additions to these infrastructures can be incorporated within the package of business models. However, this will require implementation of more flexible and agile regulation and legislation to facilitate a range of business model structures, combinations of assets and mechanisms for value creation. This is not just wishful thinking: alternative approaches are already emerging, as demonstrated by some of the examples briefly introduced throughout this report from an initial review of UK and international infrastructure business models.[25*]

Central to the iBUILD programme is the development and coordination of a number of place-based case studies – many of which are cited within this document – that are enabling us to integrate the multi-disciplinary expertise from across the research team and explore the practicalities of implementing new approaches on applied problems. However, to better promote an integrated approach to local infrastructure delivery, more substantial demonstrator initiatives should be established. New-towns, including eco-towns, could be established using conventional and alternative business models that incorporate social, economic and environmental needs; whilst an established urban area could be challenged to weave alternative ways of infrastructure delivery into its fabric. These test sites would become an essential part of a coordinated set of national facilities for experimentation, modelling and simulation for the advance of infrastructure research.

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